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(54) MULTI-STATION ULTRASONIC CLEANING PLANT
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(57) CLAIM

1. Apparatus for cleaning articles comprising: a loading end and an unloading end joined by a plurality of cleaning stages, each cleaning stage comprising a cleaning tank; means to support said articles; means to periodically transfer said support means from the loading end to the unloading end via the cleaning stages; and means to periodically lower and raise said support means into and out of each cleaning tank.

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Complete specification for the invention entitled:

"ULTRASONIC CLEANING APPARATUS"

The following statement is a full description of this invention,
including the best method of performing it known to us :-

This invention relates to apparatus for cleaning articles particularly apparatus for cleaning surgical instruments by use of ultrasonic cleaning techniques.

5 Surgical instruments have been cleaned in the past by placing the instruments in a tank of water and detergent in which there are ultrasonic transducers which transmit ultrasonic energy into the fluid. The ultrasonic energy has the effect of producing "cavitation" of the fluid against the instruments which causes release and disintegration of
10 suspensions such as blood and other organic matter from the instruments.

In large hospitals there is a great demand for rapid and efficient cleaning of surgical instruments. However, a problem with a machine for ultrasonically cleaning such
15 instruments is that the ultrasonic waves can cause excessive noise in the work area and therefore the machine has to be insulated from the surroundings. Adequate insulation is a particular problem with the machine which continuously and automatically cleans surgical instruments, since there is
20 a problem in adequately sealing the infeed and outfeed zones of the machine.

According to one aspect of the present invention there is provided apparatus for cleaning articles comprising: a loading end and an unloading end joined by a plurality of
25 cleaning stages, each cleaning stage comprising a cleaning tank; means to support said articles; means to periodically transfer said support means from the loading end to the unloading end via the cleaning stages; and means to periodically lower and raise said support means into and out of each

cleaning tank.

5 The means to close off the cleaning stages from
the exterior preferably comprises a first inner pair of
door assemblies positioned one at each end of the cleaning
stages to close the cleaning stages from the loading and un-
loading ends respectively and a second outer pair of door
assemblies positioned between the loading and unloading ends
and the exterior respectively, each of said door assemblies
including control means to open and close the doors, the
10 control means being arranged so that in use the first pair
of doors are open when the second pair of doors are closed
and vice versa.

15 In a preferred embodiment each door assembly comprises
a door of flexible sheet material arranged to be driven be-
tween a pair of guide channels located against opposed edges
of the door.

 Preferably a length of chain is attached to the sheet
material and driven by a sprocket so that the door can be
reversibly displaced from an open to a closed position.

20 The guide channel on each side of the door preferably
comprises a first upper section arranged to support the door
in a horizontal plane, a second corner section and a third
vertical section arranged to support the door in a vertical
plane, the door being displaceable along the channel from
the first section to the third section from the open to the
25 closed position.

 Preferably the channel sections are constructed of
plastics channel having a longitudinally extending narrow slot
in which the adjacent edge of the door is arranged to slide.

The door assembly may also include means to ensure positive location of the chain on the sprocket. The chain is preferably positioned adjacent the centre of the sheet material constituting the door. The sheet material is preferably a single piece of stainless steel and may be provided with a inturned flange at one end to strengthen the door and improve the seal of the door on an associated surface when closed.

Means to transfer said articles preferably comprises a longitudinally extending beam having a plurality of spaced apart pushing cross members attached thereto, means to impart reciprocating motion to said beam in a longitudinal direction so that in use, in one cycle, each cross member pushes the means to support the said articles from one stage to the next stage and returns to its initial position in said one stage.

Preferably the means to lower and raise the articles comprises a gantry assembly comprising a plurality of support platforms joined to an overhead boom, said support platforms being spaced apart at positions corresponding to each of the cleaning stages and means to cause reciprocal vertical movement of said boom to cause each support platform to descend or ascend to or from each tank of the respective cleaning stage. In an preferred embodiment each of said support platforms are joined to the boom by at least one vertically extending pillar, the pillar being positioned outside the path of the beam and associated cross members. Each end of the boom may be located in a vertically extending guide channel to prevent longitudinal

and transverse movement of the boom relative to the apparatus.

In a preferred embodiment the apparatus is used for cleaning surgical instruments and comprises four cleaning stages comprising in order, two ultrasonic cleaning stages, a rinsing stage and a drying stage.

The instruments are preferably supported by wire baskets which are pushed in use by cross members of the beam from one stage to another. The baskets are successively positioned on the respective support platforms of the gantry assembly. Bridging means may also be provided to ensure smooth movement of the baskets from one support platform to another.

Each tank may be provided with guide means to guide the baskets as they descend into the tank.

The apparatus may also be in two halves which can be bolted together at the longitudinal mid span of the apparatus to ease the assembly of the apparatus in a confined space.

According to a further aspect of the present invention there is provided a method of cleaning articles in apparatus including a loading end and an unloading end with a plurality of cleaning stages positioned therebetween, first inner means to open/close the cleaning stages from both the loading and unloading ends and second outer means to open/close both the loading and unloading ends from the exterior, the method comprising the following sequential steps:

- (a) placing the articles in the loading end with the first means closed,

- (b) closing the second means,
 - (c) opening the first means,
 - (d) mechanically transferring the articles into a first cleaning stage,
 - 5 (e) closing the first means and opening the second means,
 - (f) cleaning the articles,
 - (g) placing additional articles into the loading end,
 - (h) closing the second means and opening the first means,
 - 10 (i) mechanically transferring the articles from said first stage to a second cleaning stage, whilst at the same time,
 - (j) mechanically transferring said additional articles into the first cleaning stage,
 - 15 (k) cleaning both sets of the articles,
 - (l) repeating the method from step (e) until all the articles have been mechanically transferred successively through all the cleaning stages to the unloading end of the apparatus, and
 - 20 (m) removing the articles from the unloading end with the first means closed and the second means open.
- The method preferably also includes mechanically

lowering the articles into a cleaning tank within each cleaning stage and on completion of cleaning raising the articles from the tank to allow transfer to the next tank.

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The method preferably includes successively passing the articles into a first ultrasonic cleaning tank, a second ultrasonic cleaning tank, a rinsing tank and a drying tank.

Preferably the articles are transferred from one stage to another by locating the articles in baskets and pushing the baskets through the respective stages. The pushing action is preferably performed by horizontally displacing pushing arms against the baskets to push the baskets. The pushing arms preferably push the baskets to a desired position above the tank associated with each stage, the method also preferably includes backing off the pushing arms each by a short distance to ensure that the arms do not foul the baskets as they are lowered into the associated tank.

In accordance with a further aspect of the present invention there is provided a door assembly comprising a pair of spaced apart guide channels, each channel comprising two substantially mutually perpendicular sections joined by a curved section, a door having its lateral edges located by said channels, said door comprising a flexible sheet of material, and driving means arranged to engage the door to slide the door relative to the guide channels to and from an open and closed position.

Preferably a length of chain is secured to the flexible sheet and is arranged to be driven by a sprocket. Each channel of the assembly preferably comprises an upper horizontal section and a lower vertical section, the door being stored in the upper section when in the open position. Each section is preferably constructed of plastics material and has a longitudinal extending slot in which the associated edge of the flexible sheet is located.

The present invention will now be described by way of example only with reference to the accompanying drawings in which:

5 Figures 1 and 2 are side elevational views of apparatus for cleaning surgical instruments illustrating the left and right hand side of the apparatus respectively,

 Figures 3 and 4 are plan views of the apparatus illustrated in Figures 1 and 2,

10 Figure 5 is a partial side elevation of the apparatus with a transporting mechanism highlighted,

 Figure 6 is a partial plan view of the apparatus with the transporting mechanism highlighted,

 Figure 7 is an end on elevation view of part of the apparatus illustrating a door assembly, and

15 Figure 8 is a section taken along the line B-B of Figure 7.

 Apparatus for cleaning surgical instruments as shown in Figures 1 to 6 comprises a rectangular framework of metal girders which is arranged to be stood on the floor of a
20 hospital. The framework is split into six zones each zone being divided from the adjacent zone by vertically and longitudinally extending metal channels 2 and 2a. As viewed from left to right on Figures 1 and 2 and 3 and 4 the apparatus comprises a loading zone 3, a first cleaning zone 4, a second cleaning zone 5, a rinsing zone 6, a drying zone 7
25 and finally an unloading zone 8. To clean the surgical instruments the instruments are simply loaded into the machine at the loading zone in wire baskets, passed through the two cleaning zones, the rinsing and the drying zone and then

unloaded at the unloading zone. The apparatus is split into two levels, an upper transporting level and a lower cleaning rinsing and drying level. The instruments are lifted in and out of the cleaning zones and transferred from one zone to the next in the upper level.

Each cleaning zone comprises a rectangular tank 10, 11, which is located towards the base of the apparatus and as shown in Figure 2 is positioned towards one side of the apparatus. Each cleaning tank 10, 11 comprises a pair of base diaphragm plates 12, 13 having externally secured thereto thirty five ultrasonic transducers which are arranged to impart the ultrasonic energy into a water and detergent mixture which is held in the cleaning tanks. The rinsing zone also includes a rectangular tank 14 which is located in a similar manner to the cleaning tanks 10 and 11 and which is provided with water inlets and outlets 15 and impellers (not shown) to provide turbulent circulation of water within the tank to rinse the cleaned instruments. At the same level as the other tanks there is provided a drying tank 16 which is connected via ducting to a source of hot air 17 beneath the unloading zone, the hot air being arranged to be circulated past the instruments within the drying tank.

To clean the instruments they are initially placed in four metal baskets (now shown) which are stacked in two's in a side by side configuration in a plastics coated metal support frame (not shown). The support frame is placed on a support platform 34 positioned approximately half way up the loading zone 3. Sensors (not shown) are provided within the loading zone to ensure accurate positioning of the baskets and

transfer the baskets of instruments from the loading zone to a succession of support platforms 30, 31, 32 and 33 located one above each of the cleaning, rinsing and drying tanks respectively. Each support platform 30 to 33 is arranged to be hung from an overhanging boom 42 of a gantry assembly 40 via a pair of spaced vertically extending support pillars 41, 43, 45, and 47 respectively. Each platform comprises an open rectangular frame as shown in Figure 2 and the support pillars 41, 43, 45 and 47 support the platform adjacent one edge of each platform and the longitudinal edge 46 of the boom 42.

A lowering mechanism is secured to the gantry assembly 40 to allow the support platforms to be lowered into the associated tanks and lifted therefrom so the instruments can be positioned within the respective tanks and also lifted clear of the tanks to be transferred to the next stage. After the baskets have been dried in the drying zone 7 they are transferred to a support platform 35 in the unloading zone of the apparatus from which the baskets of cleaned and dried instruments can be removed from the associated support frame (not shown.)

The transferring mechanism is illustrated with the lowering mechanism in Figures 5 & 6 by the use of heavy lines for the transporting mechanism. The mechanism comprises a longitudinally extending walking beam 19 arranged on one side of the apparatus as shown in the plan view (Figure 6). This beam is located outside the walls of the various tanks and therefore outside the path through which the support platforms move. The beam is provided with a plurality of equally spaced transversely extending cross members 22 to 28. The spacing

of the cross members is such that a support frame for the baskets can be positioned therebetween with a gap in the longitudinal direction between one edge of the frame and the adjacent cross member. As shown in Figure 5 each cross member is of rectangular cross section but is secured to the beam on a diagonal of its cross section thereby producing a shape leading edge 21 which constitutes a pushing edge of the cross member. One end of the walking beam is secured to an inclined guide 72 having a longitudinal slot 73 into which is located a slide 74 secured to a crank arm 71 which is coaxially mounted about a driving wheel 70. The driving wheel 70 is driven by the geared output 76 of an electric motor 77 via chains 75. The electric motor 77 is provided with a brake so that the driving wheel 70 and walking beam 19 can be quickly stopped when desired. To operate the transfer mechanism the electric motor 77 drives the driving wheel 70 which in turn causes the crank 71 to rotate in a clockwise direction, rotation of the crank 71 causing the slide 74 to move up and down the longitudinally extending slot 73 in the guide 72 thereby causing the walking beam 19 to reciprocate back and forth horizontally through two extreme positions, namely a position as shown in full line on Figures 1 and 5 in which the ends of the beam span the cleaning, drying and rinsing zones 4 to 7, and to a second position shown dotted in Figure 1 in which the left hand end of the walking beam is within the loading zone 3 with the right hand end of the beam terminating at the join between the rinsing and drying zone. Accordingly, movement of the beam can be arranged so that the cross members push a pair of baskets from one zone to the next

zone so that the baskets can be transferred from the various support platforms from one end of the apparatus to the other. The driving mechanism described above produces a sinusoidal velocity profile which is ideally suited to the precise cyclic operation of the apparatus which will be described later.

Lifting and lowering of the gantry assembly 14 is effected by a pair of spaced apart driving wheels 50 and 50a rotatably mounted on an inclined support member 48, 49 attached to the frame of the apparatus as shown in Figure 1. Each of the driving wheels is connected to each end of the boom 42 via a push rod 53 which is pivotally secured to the boom 42 at one end and pivotally secured at the other end through a crank arm 52 driven coaxially with the driving wheel 50. A similar arrangement is illustrated at the other end of the gantry assembly using the prefix a. Both driving wheels are driven by an electric motor (not shown) via a continuous chain 58 which assumes the path shown in Figure 1 and is driven by a driving sprocket 57 through an idling sprocket 59. Rotation of the driving wheels 50 and 50a causes the crank arm 52 to rotate and the push rods 53 and 53a to move up and down in a vertical plane thereby raising or lowering the support platforms 30 to 34 from a first position, shown dotted in Figure 1, to a second position (not shown) in which the associated baskets will be totally immersed within the tanks associated with the cleaning, rinsing and drying zones.

To guide the gantry assembly 40 in its vertical movement each end of the boom 42 is secured to a triangular flange member 60, 61 each having a vertically extending sliding face 63 which is arranged to be a sliding fit within a slot in a vertically extending plastics guide 64. The location of the flanges in the guides not only locates the boom transversely but acts as an insulator against sound being transmitted up the columns 41, 44, 45, and 47 and into the frame of the apparatus.

10 A problem which can be encountered with such apparatus is that the ultrasonic cleaning tanks have to be carefully insulated from the exterior in view of the pitch of the ultrasonics. Accordingly, the base, sides and roof of the apparatus are lined with lead or other suitable
15 insulating material but there is still a problem that the sound waves can escape via the loading and unloading zones of the apparatus. To overcome this problem and to ensure that at no stage during the operation of the apparatus the sound waves are free to escape to the exterior, a first
20 pair of inner door assemblies 100, 101 are positioned one to extend between the loading zone 3 and first cleaning zone 4 and the other between the drying zone 7 and unloading zone 8. A second pair of outer door assemblies 102 and 103 are
25 positioned one across a side door of the loading zone 3 and the other across a side door of the unloading zone 8. The various door assemblies are shown in dotted lines on Figures 1 and 2. Each door assembly is designed to operate

in a similar manner and can be described with reference to Figures 7 and 8 which illustrate the details of operation of each of the door assemblies.

Each door comprises a flexible stainless steel sheet 110 which is arranged to extend across the width of the operational part of the apparatus and, in the closed position, from the top to the mid span of the apparatus to form a complete seal between the operational areas of the apparatus on opposite sides of the door.

Each side edge of the sheet is arranged to be a sliding fit within a narrow slit 125 defined by three channel sections, a horizontal upper section 126, a curved corner section 127 and a vertical lower section 128. The channels are constructed of plastics and act as guides for movement of the door from an open position shown in Figure 4 to a closed position in which an inturned flange 121 adjacent the base of the door contacts a rubber strip (not shown) which is located on a transverse cross member 122 between the upper and lower levels of the apparatus.

As shown in Figure 7 the upper end 111 of the sheet 110 is provided at its mid span, transverse to the apparatus, with a single length of chain links 112 as shown Figure 7 which extends approximately three quarters of the way along the length of the steel door measured from the top to the bottom, and is rigidly secured thereto by means of rivets 113 formed integrally with the chain links 114 and located through the cross section of the door. To quieten the chain

location on the door, rubber washers can be used between the rivets 113 and the chain links 114. The chain 112 is driven by a sprocket 116 which is in turn driven by an electric motor 117 mounted on the framework in the apparatus. Rotation of the sprocket 116 causes the door to move from the open position in which the sprocket engages the teeth adjacent the end 118 of the chain 112 to a closed position where the sprocket engages the opposite end 119 of the chain 112 and in which the base of the door abuts the cross member 122.

Both the top and base edges of the door are provided with an inturned flange 121 which not only improve the rigidity of the door but the base flange 121 forms a good seal between the door and the associated platform 122. To open and close the door the sprocket 16 is driven by the electric motor back and forth from the position shown in Figure 7. The operation of the door is such that from the open to the closed position the inturned flange does not travel round the curved portion of the path of the door.

To ensure that the chain 112 does not slip relative to the sprocket 116 a plastics tensioning member 140 (Figure 7) is arranged to push the chain 112 against the teeth of the sprocket at the point of contact 141 and therefore ensure positive drive.

The opposed guide channels 126 to 128 prevent transverse and longitudinal movement of the door and ensure a smooth and efficient opening and closing operation.

As described previously four such door assemblies are provided throughout the apparatus and the timing of the opening and closing actions of the doors is arranged so that at no time is the interior of the machine, namely the cleaning, rinsing and drying zones open to the exterior.

To further illustrate the operation of the cleaning apparatus in accordance with this invention a complete cleaning cycle from start to finish will now be described.

To initially load the apparatus, surgical instruments are placed in four baskets each of which is positioned within a plastics coating supporting frame (not shown) the frames are arranged to be clipped together in a side by side arrangement and also stacked in pairs and are then positioned in pairs between the cross members 22 and 23 of the walking beam 19 which is in the dotted position shown in Figure 1. In this position the outer doors 102 and 103 are open and the inner doors 100 and 101 are closed. Once the baskets have been located on the support platform 34 in the loading zone 3 the outer doors 102 and 103 are closed and the inner doors 100 and 101 opened.

The drive wheel 70 of the walking beam is actuated to move the beam into the right hand position shown on Figure 1. This movement causes the cross members 22 and 23 to push the baskets from the platform 34 in the loading zone to the platform 30 in the first drying zone. The crank arrangement of the driving wheel 70 is such that as the cross members 22 and 23 move to the full line position in Figure 1 the beam

will have completed the amplitude of its movement so that further rotation of the driving wheel causes movement of the cross members and beam in the reverse direction.

Furthermore, the velocity profile of the beam is sinusoidal and is arranged so that the beam is travelling very slowly at its point of maximum amplitude. Accordingly, the operation continues by further rotation of the driving wheel 70 to reverse or "back off" the cross members 22 and 23 from the frame and associated baskets in the first drying zone. The cross members are only backed off by a short distance to ensure that they do not foul movement of the gantry assembly 40.

The driving wheel 70 of the walking beam is then stopped and the driving wheels 50 and 50a of the gantry assembly 40 are actuated to lower the four baskets on their platform 30 into the first cleaning tank 4. At the same time the driving wheel 70 is again actuated to complete its revolution to return the walking beam 19 to the position shown dotted in the loading zone. The inner doors 100 and 101 are then closed and the outer doors 102 and 103 opened so that four more baskets of surgical instruments can be positioned on the platform 34 in the loading zone. Whilst this is happening the ultrasonic transducers in the first cleaning tank are operated and the instruments within this tank are subjected to a cleaning operation.

The gantry assembly is then actuated to lift the baskets from the first cleaning tank back to the upper position shown dotted on Figure 1. The outer doors are then closed and the inner doors opened and the driving wheel 70 completes another revolution which has the effect of transferring the first set of baskets from the first cleaning zone to the second cleaning zone by a pushing action effected by the cross members 24 and 25 and transferring the second set of baskets from the loading zone 3 by a pushing action effected by the cross members 22 and 23.

Accordingly, by repeating these operations a set of baskets can be transferred throughout the whole length of the apparatus to be twice cleaned, rinsed and then dried and finally ejected onto the support platform 34 of the unloading zone. Furthermore, the whole apparatus can be filled with baskets of instruments so that a continuous cleaning operation takes place. When operating in this manner, the apparatus is designed to produce four baskets of instruments at the unloading zone every two minutes. The operator simply removes the baskets from the unloading zone and replaces a new set of baskets at the loading zone whilst the cleaning is taking place within the sealed cleaning compartments. The operation of the doors is carefully selected so that at no stage can the ultrasonic waves generated by the cleaning tanks escape to the exterior since, when the baskets are being loaded into the apparatus the inner doors are closed and when the baskets are being transferred into and out of the cleaning zones the outer doors are closed.

From the operation of the apparatus described above it is clear that a number of limit switches and timing devices are required to ensure that each component operates at the desired time. Within the spirit of this invention it is understood that many suitable control devices can be used to ensure synchronous operation of the various components. Furthermore, a number of safety devices may be incorporated to protect both the operator and the apparatus from unnecessary damage. The outer doors may be provided with bump strips which prevent the doors closing when the operator's hand is within the loading or unloading zones. The apparatus is designed so that no stage can operate unless one pair of doors are closed. Furthermore, sensors may be provided in the loading and unloading zones to ensure correct alignment of the basket support frames.

Other features which make up this apparatus include guide members 150 and 151 which are located within each tank at the edges and middle of the tank respectively to ensure that as the baskets are lowered into the tank they are accurately positioned relative to their associated support platform. The guide members 150 and 151 protrude through the open frame of the support platform to guide the basket support frames. If the baskets come out of line on submersion into the tanks there is a danger that as they are displaced from one zone to another they could foul the edge of the tank and jam either against each other or against the walls of the tank.

To ensure the smooth passage of the baskets from one support platform to the next, a plurality of bridging ramps (not shown) are provided between each platform to ensure the leading edge of the baskets does not lodge in a gap between the adjacent platforms. The edges of each bridging ramp are arranged to be supported by the edges of two adjacent platforms of the gantry assembly. As the platforms are lowered into the tanks the bridging ramp is supported on the adjacent edges of the tanks and after the cleaning operation has been completed, the ramp is lifted by the gantry 40 so that there is a smooth join between adjacent platforms.

Another feature of this apparatus is the capacity to split the apparatus longitudinally into two halves to enable assembly of the apparatus within a building which may have narrow corridors or small lifts. For instance, to install the apparatus in a hospital the two halves can be transported separately to the hospital and then simply bolted together. Furthermore, to ensure that the apparatus is always level, levelling jacks may be positioned between the base of the apparatus and the floor to ensure an inclination of the hospital floor is compensated.

Thus, the apparatus as described above provides an efficient semi-automated high volume cleaning apparatus for surgical instruments. The operator simply places baskets of instruments in at the loading zone and removes clean, dry instruments from the unloading zone. The ultrasonic cleaning

tanks provide the very efficient cleaning operation and the combination of the walking beam assembly and gantry assembly provides a simple and effective method of transferring the baskets of instruments from one end of the apparatus to the other through the various tanks. The steel door assemblies and other insulation ensure that the machine performs within acceptable noise standards and also protects the interior of the machine from the entry of contaminants.

It is also understood that the machine in accordance with the present invention can be used for other cleaning operations and is not limited to ultrasonic cleaning of surgical instruments.

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The claims defining the invention are as follows:

1. Apparatus for cleaning articles comprising: a loading end and an unloading end joined by a plurality of cleaning stages, each cleaning stage comprising a cleaning tank; means to support said articles; means to periodically transfer said support means from the loading end to the unloading end via the cleaning stages; and means to periodically lower and raise said support means into and out of each cleaning tank.
2. Apparatus according to claim 1 wherein the means to transfer the support means comprises reciprocating pushing arms which are arranged to push the support means onto platforms associated with each cleaning stage, said platforms each being vertically displaceable into and out of the respective cleaning tank.
3. Apparatus according to claim 2 wherein the pushing arms are secured spaced apart to a longitudinally extending beam, means being provided to impart reciprocating motion to said beam in a longitudinal direction so that in use, in one cycle, each arm pushes the support means from one stage to the next stage and returns to its initial position in said one stage.
4. Apparatus according to either claim 2 or 3 wherein the means to raise and lower the support means comprises a gantry assembly including the support platforms secured

to an overhead boom, said support platforms being spaced apart in positions corresponding to each of the cleaning stages and means to cause reciprocal vertical movement of said boom to cause each support platform to descend or ascend to or from each tank of the respective cleaning stages.

5. Apparatus according to claim 4, wherein each of said support platforms are joined to the boom by at least one vertically extending pillar, the pillar being positioned outside the path of the pushing arms to allow movement of the support means without fouling the gantry assembly.

6. Apparatus according to any one of claims 2 to 5 wherein bridging means are provided between each cleaning stage to ensure a smooth pushing movement of the support means from the support platform of one stage to the support platform of the adjacent stage.

7. Apparatus according to any one of claims 1 to 6, wherein within each tank is provided guide means to position the support means as they descend into the tank.

8. Apparatus according to any one of the preceding claims wherein the support means for the articles comprises wire baskets.

9. Apparatus according to any one of the preceding claims, wherein the apparatus is also provided with means to close off said cleaning stages from the exterior of the

apparatus at all times during loading and unloading of the apparatus.

10. Apparatus according to claim 9, wherein the means to close off the cleaning stages from the exterior comprises a first inner pair of door assemblies positioned one at each end of the cleaning stages to close the cleaning stages from the loading and unloading ends respectively, and a second outer pair of door assemblies positioned between the loading and unloading ends and the exterior respectively, each of said door assemblies including control means to open and close the doors, the control means being arranged so that in use the first pair of doors are opened when the second pair of doors are closed and vice versa.

11. Apparatus according to claim 10, wherein each door assembly comprises a door of flexible sheet material arranged to be driven between a pair of guide channels located against opposite edges of the door.

12. Apparatus according to claim 11, wherein links of a chain are attached to the sheet material and are driven by a sprocket so that the door can be reversibly displaced from and open to a closed position.

13. Apparatus according to either claim 11 or claim 12, wherein the guide channel on each side of the door comprises a first upper section arranged to support the door in a horizontal plane, a second corner section and a third

vertical section arranged to support the door in a vertical plane, the door being displaceable along the channel from the first section to the third section from the open to the closed position.

14. Apparatus according to claim 12, wherein the door assembly is provided with means to ensure positive location of the links on the sprocket.

15. Apparatus according to any one of claims 11 to 14, wherein the sheet material is formed of a single piece of stainless steel provided with an inturned flange at each end to stiffen the sheet and improve the seal of the door on an associated surface when closed.

16. Apparatus according to any one of the preceding claims for cleaning surgical instruments and comprising four cleaning stages, including in order, two ultra-sonic cleaning stages, a rinsing stage and a drying stage.

17. A method of cleaning articles in apparatus including a loading end and an unloading end with a plurality of cleaning stages positioned therebetween, first inner means to open/close the cleaning stages from both the loading and unloading ends and second outer means to open/close both the loading and unloading ends from the exterior, a method comprising the following sequential steps:

(a) placing the articles in the loading end with the first means closed,

- (b) closing the second means,
- (c) opening the first means,
- (d) mechanically transferring the articles into a first cleaning stage,
- (e) closing the first means and opening the second means,
- (f) cleaning the articles,
- (g) placing additional articles into the loading end,
- (h) closing the second means and opening the third means,
- (i) mechanically transferring the articles from said first stage to a second cleaning stage, whilst at the same time,
- (j) mechanically transferring said additional articles into the first cleaning stage,
- (k) cleaning both sets of articles,
- (l) repeating the method from step (e) until all the articles have been mechanically transferred successively through all the cleaning stages to the unloading end of the apparatus, and
- (m) removing the articles from the unloading end with the first means closed and the second means open.

18. A method according to claim 17 further comprising mechanically lowering the articles into a cleaning tank of

each cleaning stage and on completion of the cleaning, raising the articles from the tank to allow transfer to the next tank.

19. The method according to either claims 17 or 18 comprising successively pushing the articles from platforms associated with each cleaning stage.

20. The method according to any one of claims 17 to 19 comprising successively passing the articles into a first ultra-sonic cleaning tank, a second ultra-sonic cleaning tank, a rinsing tank and a drying tank.

21. The method according to any one of claims 17 to 20 comprising transferring the articles from one stage to another by locating the articles in baskets and pushing the baskets through the respective stages.

22. The method according to claim 21 comprising horizontally displacing pushing arms against the baskets to push the baskets.

23. A method according to claim 22 including backing off the pushing arms a short distance from each basket to ensure that the arms do not foul the baskets as the baskets are lowered into the associated tank.

24. A door assembly comprising a pair of spaced apart guide channels, each channel comprising two substantially mutually perpendicular sections joined by a curved section, a door having its lateral edges located by said channels,

said door comprising a flexible sheet of material; and driving means arranged to engage the door to slide the door relative to the guide channels to and from an open and closed position.

25. A door assembly according to claim 24 wherein a length of chain is secured to the flexible sheet and is arranged to be driven by a sprocket.

26. A door assembly according to either claims 24 or 25 wherein each channel of the assembly comprises upper horizontal section and a lower vertical section, the door being stored in the upper section when in the open position.

27. A door assembly according to claim 26 wherein each section is constructed of plastics material and has a longitudinally extending slot in which the associated edge of the flexible sheet is located.

28. Apparatus for cleaning articles substantially as described herein with reference to and as illustrated in the accompanying drawings.

29. A method of cleaning articles substantially as described herein with reference to and as illustrated in the accompanying drawings.

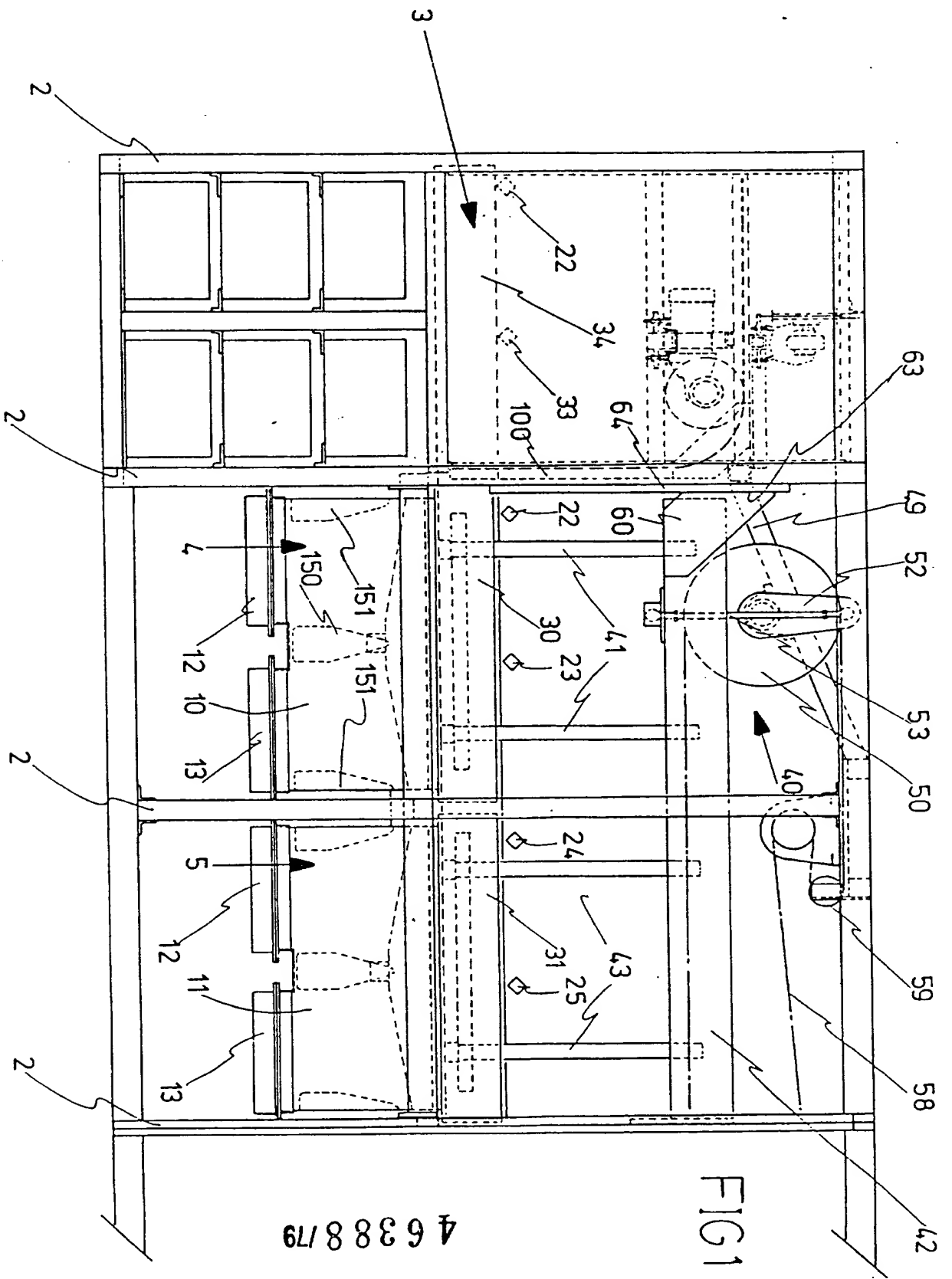
30. A door assembly substantially as described herein with reference to and as illustrated in the accompanying drawings.

31. The parts, elements, steps and features referred

to or indicated in the specification and/or claims and/or drawings of this applications, individually or collectively, and any and all combinations of any two or more of said parts, elements or features.

Dated this 24th day of April 1979

GERALD JACQUES ADOLPHE HOCHMANN
by his Patent Attorneys
DAVIES & COLLISON



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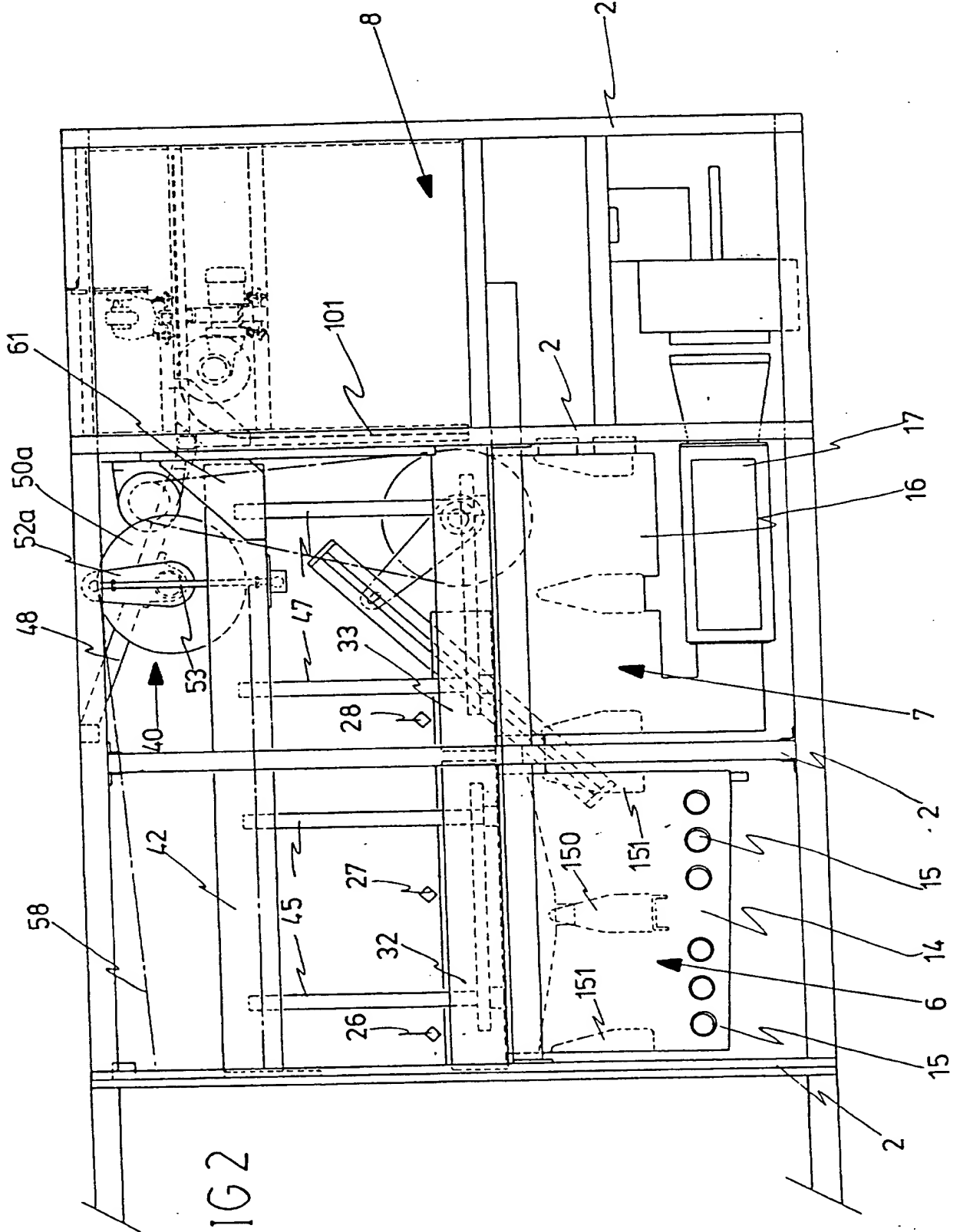
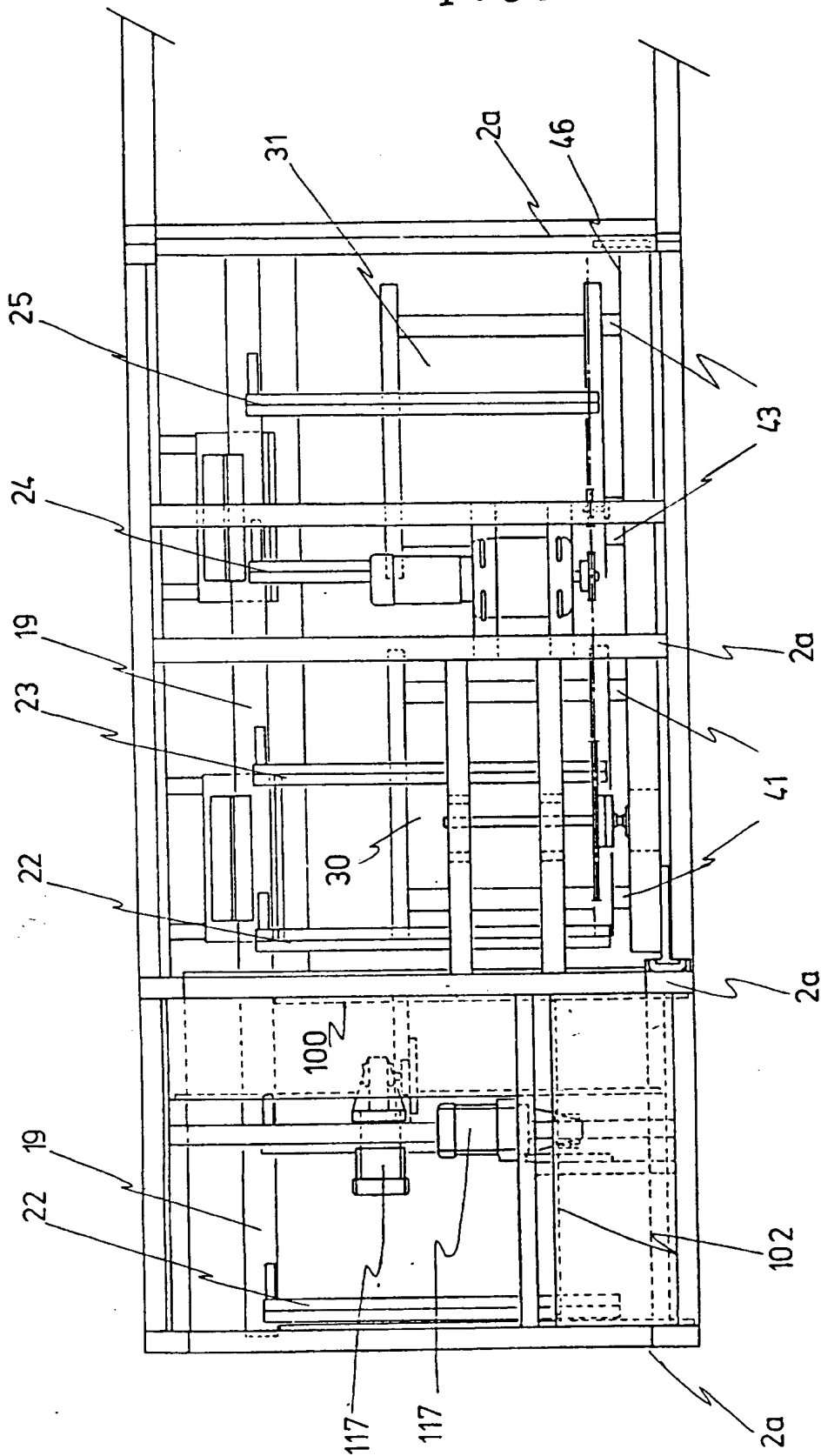


FIG 2

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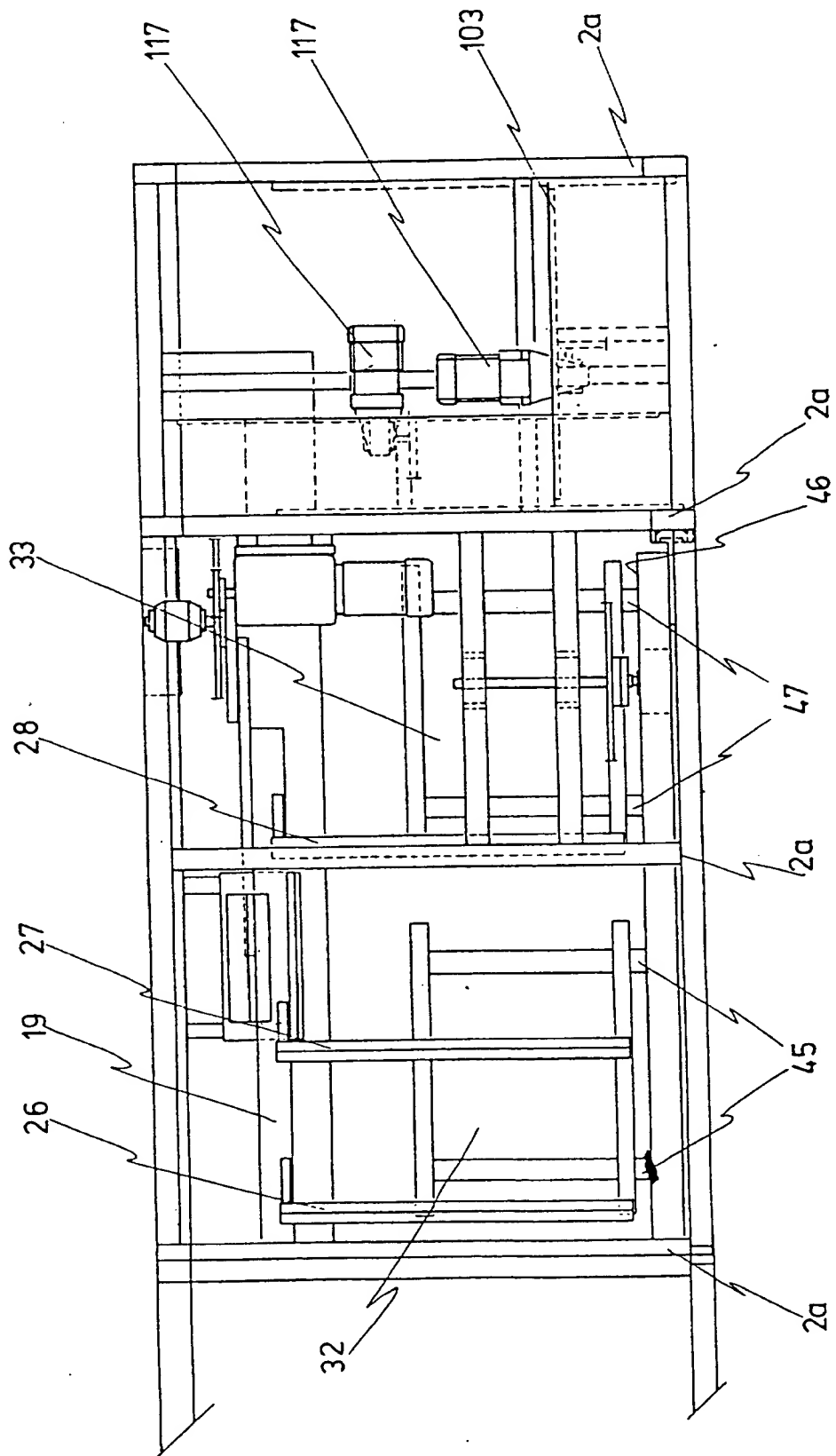
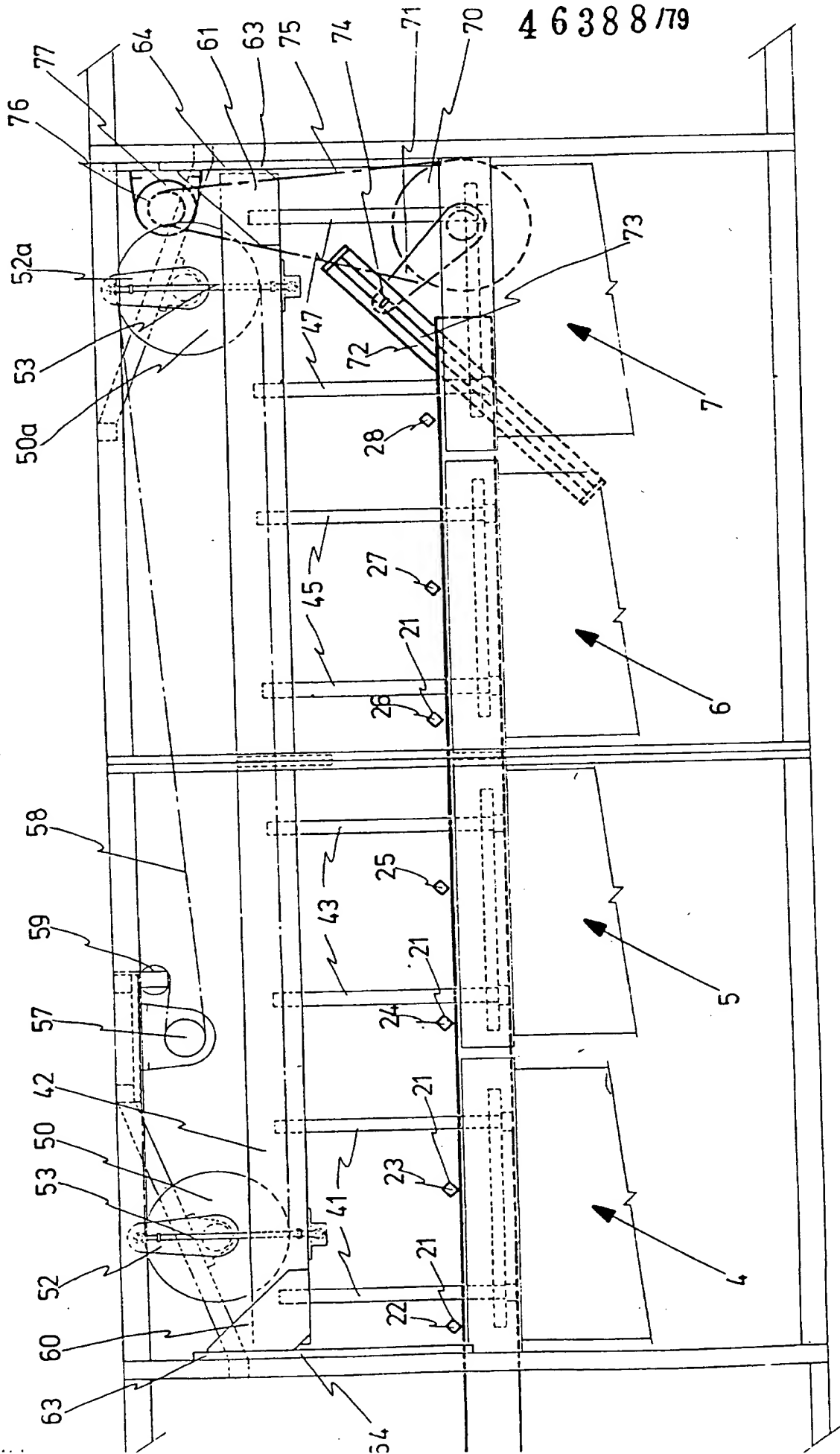


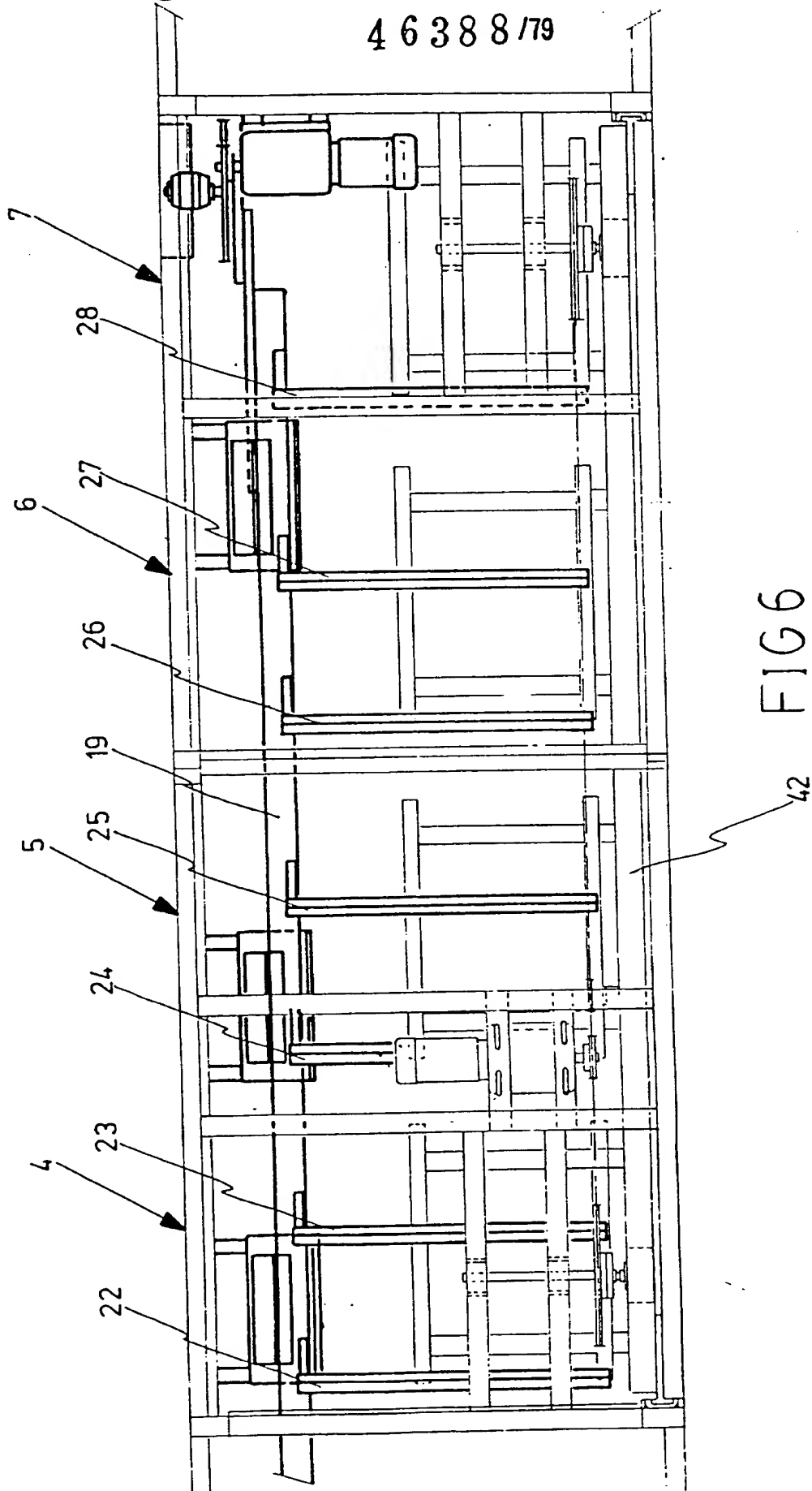
FIG 4

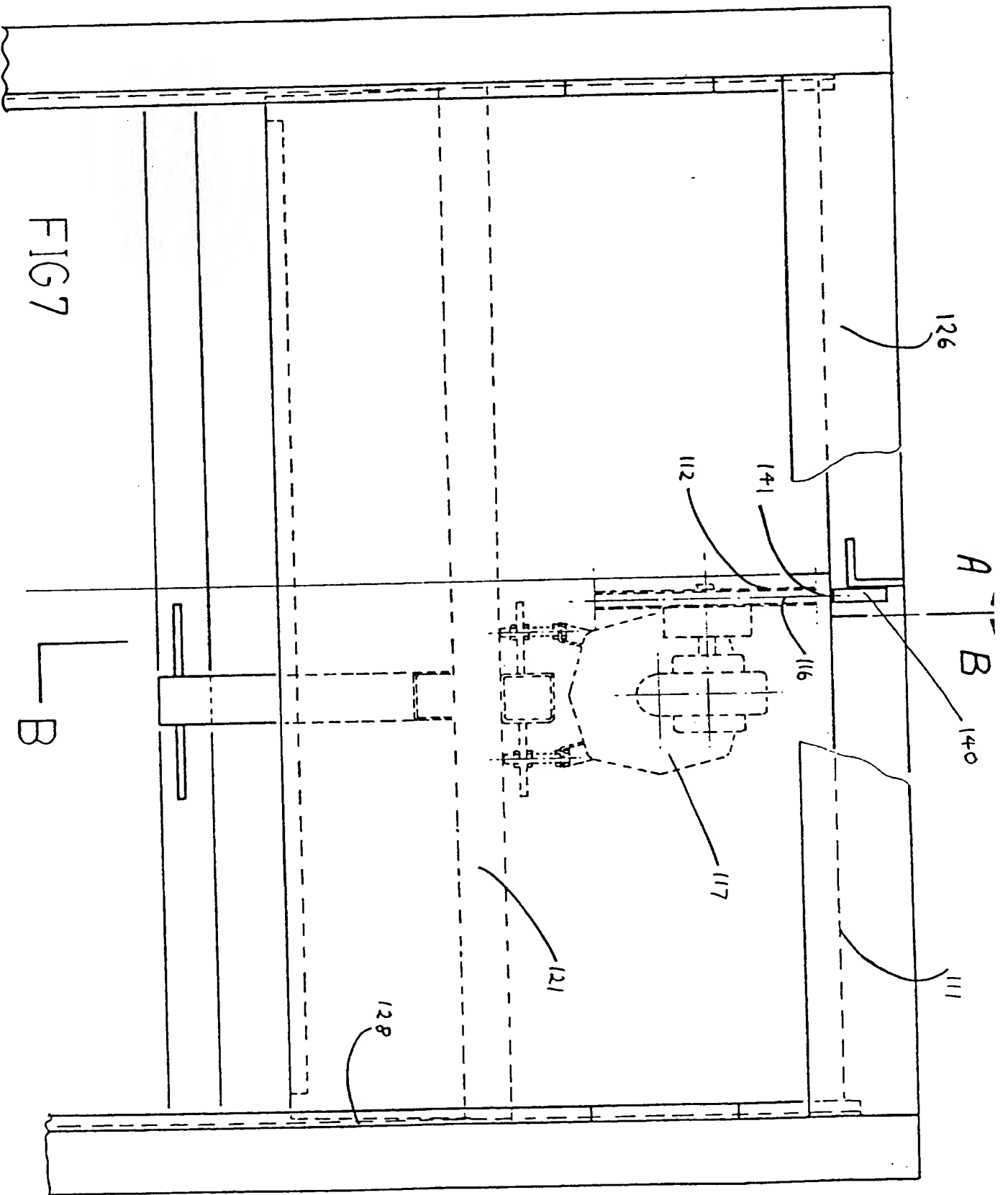
FIG 5

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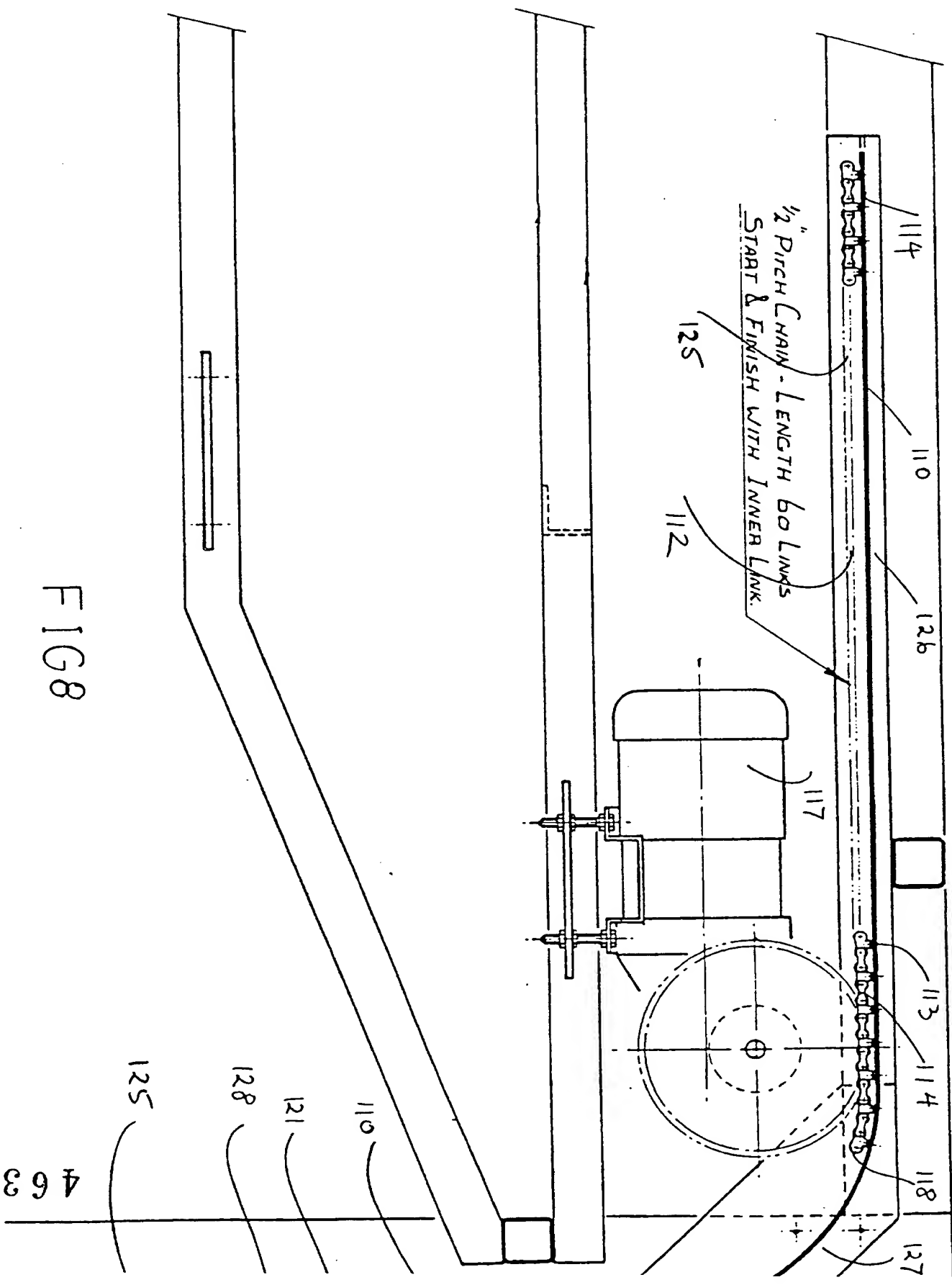


FIG 8

4 6 3 8 8 / 7 9